Crystal Growth and Optical Properties of Ce-doped (Y, Tb)$_3$Al$_2$Ga$_3$O$_{12}$ and (Gd, Tb)$_3$Al$_2$Ga$_3$O$_{12}$ Scintillators

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Introduction Scintillators are widely used in X-ray imaging, which are applied for medical diagnostics and airport security controls. To obtain images with excellent contrast in short exposure times, scintillators are required to have the high light output. Therefore, Tb-doped scintillators are noble candidate for X-ray imaging [1]. Recently, Ce and Tb co-doped scintillators such as Ce-doped (Gd, Tb)$_3$(Al, Ga)$_5$O$_{12}$ (GAGG:Ce, Tb) have been explored due to efficient energy transfer between Ce^{3+} and Tb^{3+}, which enable to improve the luminescence and scintillation properties [2]. However, the absorption spectra of GAGG show the peaks associated with Gd^{3+} 4f-4f transitions which overlap the absorption bands associated with Tb^{3+} 4f-5d transitions [3]. As a consequence, the presence of Gd in the host material introduces complexity to the behavior of energy transfer between Ce^{3+} and Tb^{3+} and presents challenges in its elucidation. To investigate the specific influence of Gd within the host material on the energy transfer between Ce^{3+} and Tb^{3+}, we conducted a comprehensive study of the optical and scintillation properties of Ce-doped (Y, Tb)$_3$Al$_2$Ga$_3$O$_{12}$ (YAGG:Ce, Tb). Through a comparative analysis of these properties with those of GAGG:Ce, Tb, our aim was to attain a more distinct understanding of the role of Gd as a host material.

Materials and Methods A stoichiometric mixture of 4N CeO_2, Tb_4O_7, Gd_2O_3, Y_2O_3, Ga_2O_3 and Al_2O_3 powders was used as starting material. Ce and Tb co-doped YAGG and GAGG crystals were grown by the micro-pulling-down method. Crystals were grown from an Ir crucible under the Ar+2%O_2 atmosphere and GAGG crystals were used as seed.

Results We were succeeded in growing transparent YAGG and GAGG crystals. Under excitation into Ce^{3+} 4f-5d band at 430 nm, the typical emission spectra associated with the Ce^{3+} and Tb^{3+} were simultaneously observed in both crystals. However, Tb^{3+} emission of YAGG crystal had higher intensity than that of GAGG crystal. The results of photoluminescence decay times and scintillation properties measurement will be presented in the conference.

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